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ABSTRACT

The practicality of using speeded speech as an educational medium was explored in an Immersion study, in a Criterion study, and in Retention studies. Tapes of novels were used for listening; compression was achieved by a device that removed small segments of the tape-recorded speech sounds and, then, abutted the remainder of the speech record together. In the Immersion study, seven male college students listened to high spped speech (425 wpm-475 wpm) for five days, 11 hours a day. The results of this experiment confirmed previous findings that comprehension of time-compressed speech can be improved by simple practice routines to relatively high levels at speeds of about 2-1/2 times normal speed. In the Criterion study, seven of 10 male college students reached criterion, or 90 percent of normal speed score at least once on a listening test presented at 375 wpm. However, they did not reach criterion consistently. The Retention studies were designed to determine to what extent the skill of listening to compressed speech is retained, and to what extent material learned via compressed speech is retained. The results indicated that content is retained, but that this may or may not be true of skill. Further research is anticipated. (MF)

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Further Research on Speeded Speech as an Educational Medium

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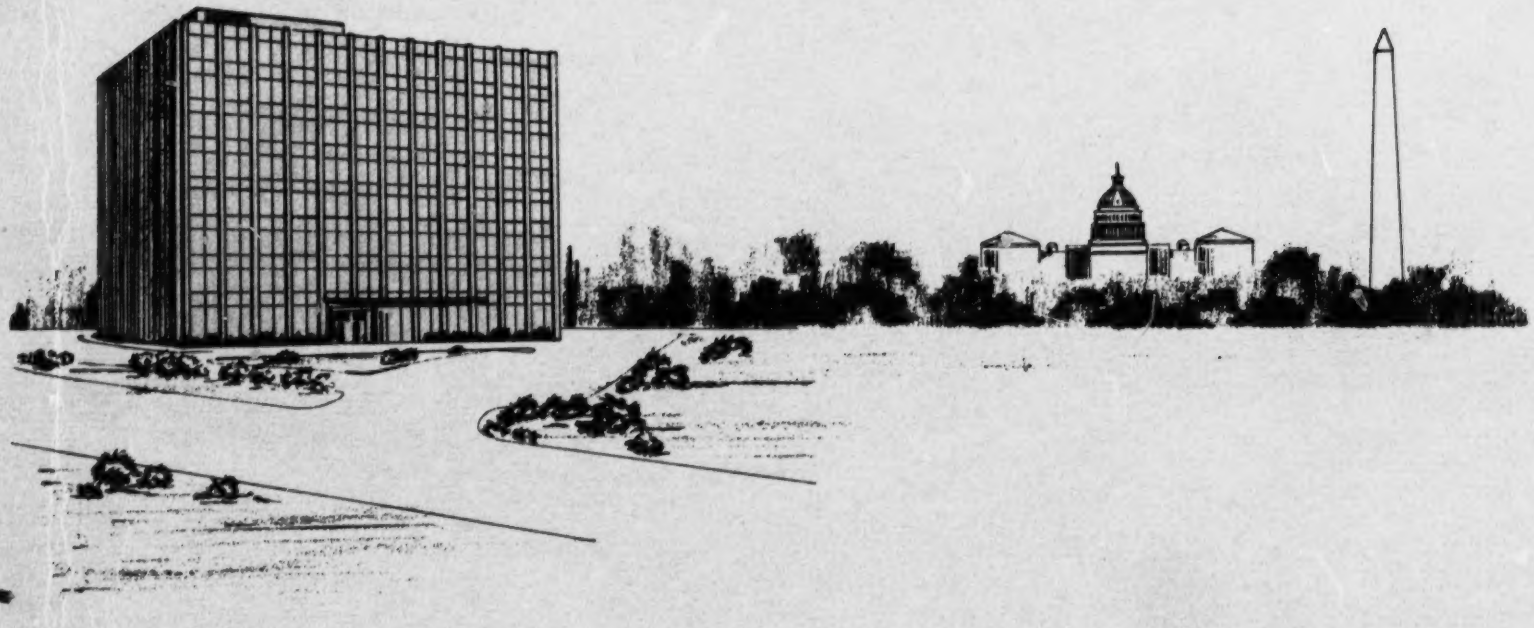

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FURTHER RESEARCH ON SPEEDED SPEECH AS AN EDUCATIONAL MEDIUM

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PREFACE

The latter portion of 1965 was a period in which considerable public interest regarding research in the comprehension of time-compressed speech was generated. The Principal Investigator arranged a symposium for presentation to the American Psychological Association in September, 1965. Most of the current research in compressed speech was represented at this symposium. This symposium resulted in a number of articles in various publications, including: Science Newsletter (10/2/65), The Chicago Daily News (9/4/65), The New York Herald Tribune (9/12/65), Education U. S. A. (9/16/65), Washington Post (9/6/65), Newsweek Magazine (9/13/65), and many other newspapers.

On 11 November 1965, our laboratory setting and research were filmed by the CBS Walter Cronkite Evening News Show. The final film, which was presented on the 22 December broadcast, featured Project Director, H. L. Friedman presenting a test to a group of subjects; CBS Washington correspondent George Herman interviewing the Principal Investigator; and the playing of a one-minute selection at 325 words per minute for the viewing audience, coupled with a request for cards and letters answering a question based on the selection and giving opinions about the technique. Editorial commentary was given by Eric Sevareid, and comments were made by Walter Cronkite who used compressed speech for his final sign-off of the evening.

As a result of this program about 4,000 cards and letters were addressed to the Principal Investigator at the P. O. Box number provided on the show. (How many arrived in New York addressed only to CBS or

to Walter Cronkite, we don't know.) The bulk of these (about 90 percent) had the correct answer to the question. About half were outspokenly favorable to the presentation (this based on exposure of only 2-3 minutes); and only about 15 percent expressed serious reservations. These reservations were in general concerned with the fast pace of modern life and the development of tension rather than doubts that the procedure would work. (In passing, it should be noted that listening to 325 wpm can be wearing, but that this feeling disappears with practice.)

Finally, CBS footage was made available to the United Press International for use in their monthly filmed edition of Science News Report for the U. S. Information Agency. This film was scheduled for release in February-March 1966 and distribution to about 525 outlets in 75 foreign countries, in 22 different languages from Urdu to French. This represented about 96 percent of USIA stations including Warsaw, Budapest, and Belgrade.

The public reaction described above has not had a great deal of impact on the conduct of the research described in the remainder of this Report. However, it has served to impress the authors with the high degree of potential public acceptance which may be anticipated when these techniques are taken into the field testing and implementation stages sometime during the next year or two.

Introduction and Background

In recent years, considerable attention has begun to be given to raising the rate and level of auditory comprehension. Interest in listening comprehension is of course not new. Interest in the trainability of listening rate is perhaps more recent, but as far back as 1947, Nichols (1947, p. 85) posed the question, "Can listening rate, like reading rate, be increased through training?". Attempts to study rapid speech have invariably reported severe attenuation of comprehensibility with increased rates of presentation. Until recently such studies have used speeded-up tapes or records to increase speech rate and the resulting frequency shift has produced speech of higher and higher pitch. Many investigators concluded that loss of comprehension was as much due to frequency shift as to the acceleration of speech itself.

One investigator, (Garvey; 1953a, 1953b) reasoned that since Miller and Licklider (1950) had demonstrated that good intelligibility remained even after considerable loss of the stimulus word, it would be possible to physically cut out small segments of the speech record and play the remainder, thus compressing the total speech time, but leaving the original frequencies unaltered. Using discrete, spondaic words, Garvey found it possible to compress speech up to 2. 5 times without losing more than 20 percent intelligibility.

Garvey's compression technique was far too cumbersome to be applied on any large scale. However, Fairbanks and his colleagues (1954, 1957), developed an electronic device for doing essentially what Garvey did by hand, with similarly encouraging results. More recently,

Bixler, Foulke, et al. (1961) began investigations of speech compression as an approach to teaching the blind, again demonstrating the feasibility of the technique.

During the past three years under the sponsorship of the U. S. Office of Education, the authors have conducted investigations at the American Institutes for Research inquiring into the ability of college students to understand tape recorded material at speeds greater than normal. This research has been made feasible by the use of a device (The Tempo Regulator), somewhat similar to that developed by Fairbanks, which electronically removes small segments of the tape recorded speech sounds and abuts the remainder of the speech record together. Since the process removes only segments shorter than the shortest speech sounds, the result is relatively distortion-free; in addition pitch and intonation patterns remain normal.

Previous progress reports have described three major experiments whose results may be briefly summarized as follows: By the end of the experiments, all experimental groups achieved significantly higher comprehension at 425 wpm than the control groups. Three of the four experimental groups showed a significantly higher mean gain score than control groups on a passage given at 475 wpm at the beginning of the experiment and repeated at the same speed at the end. There have been no major changes in pre- and post-experimental reading performance measures. No differences in normal speed listening performance as a function of listening to rapid speech have been detected with an abbreviated version of the STEP Listening Test. Virtually all subjects have reported that they feel that they benefited from practice and that compressed speech has a place in the educational setting. Male and female subject performances were not discriminably different. Increasing the rate of practice

material from 325 to 475 in 50 wpm increments seemed somewhat superior to presenting all practice at 425 wpm. Interrupting the usual 45 minute listening sessions for three minute breaks every ten minutes did not improve performance as compared to uninterrupted practice, and, although the differences were not significant, actually appeared to be an inferior method of practice.

The research reported in the present progress report covers three types of experiments conducted since the last progress report (July 1965): The Immersion Study, in which subjects listened to many hours of high speed listening for a week; The Criterion Study in which moderately high speed practice was presented until the subjects reached a pre-set criterion; and the Retention Studies in which an attempt was made to determine how well the skill, and the content of material was retained over a period of time.

The Immersion Study

Problem:

It was the purpose of this experiment to determine the effects of listening practice when that practice was given intensively; approximately 8-10 hours a day for five consecutive days. In previous experiments practice had been presented at high speed exclusively (425 wpm throughout), and at graduated speeds (325, 375, 425, and 475 wpm); but in these cases practice had been given on alternate weekdays and spread over four weeks. In this experiment subjects put in a twelve hour day (9:00 a. m. to 9:00 p. m.) including breaks for meals and rest, and were given practice material only at 425 wpm. The major question asked was whether con-

centrated practice in a few days could achieve results similar to or better than those provided by spaced practice.

The rationale for the problem was two-fold. In the first place if it should, as seems likely, become feasible to apply time-compressed speech as a general educational technique, it might be necessary to have naive students spend some amount of time practicing the comprehension of time-compressed speech as a precursor to their regular studies. If this were the case, it would be desirable to have such a training course occupy a minimum number of days at the beginning of the term. Secondly, the experience of the Armed Services in recent years in attempting to teach a second language has shown a fair amount of success for intensive or immersion exposure to the target language.

Putting these factors together, it seemed to be worthwhile to see whether or not exposure to compressed speech of the order of 8 to 10 hours a day for a period of a week could produce results equivalent to or better than those which had been previously obtained on a more relaxed schedule.

Procedures:

The immersion study subjects consisted of seven male students, between ages 19 and 20, at the freshmen or sophomore college level. English was their native language and none had a marked regional accent. The average letter grade for all the students in their last semester in college was a C+. Two of the subjects had some training in rapid reading but in both cases the course was not completed. None of the subjects had had any form of training in listening. All of the subjects were screened audiometrically for normal hearing.

In the first session, subjects were given a brief talk explaining

that the purpose of this study was to provide intensive exposure to speeded speech, and to measure listening performance with periodic benchmark tests. They were also given a biographical data sheet to fill out which called for basic information about their backgrounds. They were then given alternate forms of the Nelson-Denny reading test which measures reading comprehension, rate, and vocabulary. This was followed by the presentation of an historical passage (taken from the same book as the later benchmark passages) which was presented at normal recording speed (175 wpm). A standard multiple choice test on the information contained in the passage was then given. A similar passage and test was then presented at 475 wpm as an initial measure of high speed performance. Subjects were then asked to return for five consecutive weekdays, beginning on a Monday, from 9:00 a. m. to 9:00 p. m.

During the next week, twelve novels were played at 425 wpm as practice material for the subjects. The experiment was conducted in a semi-soundproofed room and materials previously compressed on the Tempo Regulator were played back on a Magnecord tape recorder through a Bogen amplifier and two Electro-voice speakers. The novels used and the days on which they were presented are shown in Appendix A.

On each day listening material was presented for approximately 48 minutes without interruption. At the end of that time a brief written quiz, including both short answer and essay types of questions, was administered to the subjects during a ten minute period. This was followed by a five minute rest period, after which the cycle was repeated. Subjects were given one hour for lunch during the afternoon, and one hour for dinner in the evening. During the latter part of each of the five days of exposure,

a new benchmark passage and test, similar to the pre-experimental material, was administered. Each test was presented at 425 wpm. Near the end of the fifth day, the initial high speed benchmark passage was presented again at 475 wpm.

At the end of testing and again in a post-experimental session about a week later, subjects were asked to rate the novels they had listened to, on a five point scale, covering the following aspects of the presentations: Overall ability to comprehend, intelligibility (clarity of individual words), difficulty of subject matter, interest in the book, quality of speaker's voice, and quality of speaker's diction.

An alternate form of the Nelson-Denny reading test was then presented as a post-experimental measure of change. The subjects were then given an extensive debriefing questionnaire to complete calling for subjective comments on the procedures, materials, and potential usefulness of compressed speech in the educational setting.

Upon the completion of the experiment, each subject was paid $100.00 plus a bonus of $25.00 to the subject who demonstrated the greatest proficiency on the benchmark tests.

Results and Discussion:

Results of the benchmark tests in terms of number of questions correct, based on 25-item tests, corrected for chance, are shown in Table 1. Also shown is percentage of normal speed performance, calculated separately for each individual based on his own performance at normal (175 wpm) speed. It may be noted that there is a progression of means from 40.4% on Day 1 to 70.0% on Day 5, which is reasonably steady with the exception of a dropback on Day 2. In addition to this improvement, mean performance on the repeated high speed passage

TABLE 1

Benchmark Test Scores Corrected For Chance and Percentages of Normal Speed Scores

Subject		Normal	475(1st)	425 WPM					475(2nd)
				Day 1	Day 2	Day 3	Day 4	Day 5	
A		16.25	0.00	6.50	2.75	7.50	8.75	9.37	9.37
	%	100.0	0.0	40.0	16.9	46.2	53.8	57.7	57.7
B		14.00	5.21	9.50	9.75	8.75	7.50	9.58	12.29
	%	100.0	37.2	67.9	69.6	62.5	53.6	68.4	87.8
C		25.00	8.33	15.00	8.75	16.25	10.00	17.70	11.45
	%	100.0	33.3	60.0	35.0	65.0	40.0	70.8	45.8
D		22.50	8.95	16.25	11.50	14.00	13.75	16.09	15.62
	%	100.0	39.8	72.2	51.1	62.2	61.1	71.3	69.4
E		19.25	1.46	0.75	3.75	6.75	14.00	9.58	6.66
	%	100.0	7.6	3.9	19.5	35.1	72.7	49.8	34.6
F		14.25	0.00	1.25	6.50	1.25	3.75	11.45	4.16
	%	100.0	0.0	8.8	45.6	8.8	26.3	80.4	29.2
G		10.00	2.08	3.00	0.50	4.00	6.50	9.16	3.96
	%	100.0	20.8	30.0	5.0	40.0	65.0	91.6	39.6
Mean		17.32	3.72	7.46	6.21	8.36	9.18	11.84	9.07
	%	100.0	19.8	40.4	34.7	45.7	53.2	70.0	52.0

(475 wpm) also improved from 19.8% to 52.0%, which is significant at the one percent level. The progression of means is shown graphically in Figure 1.

With the exception of the 475 wpm passage and test, the figures shown in Table 1 and Figure 1 are based upon different tests and test passages are thus independent estimates of performance. Passages were taken from the same book of early English history, however, and tests were constructed to be equivalent according to item statistics derived from the same population of students.

As an illustration of the extent to which variables such as material and subject variability and type of test can affect the results, however, one may consider the results for the short answer tests and essay tests on the practice materials. These were not intended to do more than motivate the subjects to listen to the practice materials, and it was not possible to standardize these measures. The results on these tests showed no discernable trends and great subject variability. The lack of correlation between short answer and essay results (R=0) indicated further that such measures are not very dependable. To the extent that investigators are led to depend upon such "pick-up" measures, their research can certainly be open to question.

With respect to pre- and post-test scores on the reading and standard listening tests, mean increases of about 7-8 percent were observed in each case. Of course, these results were not significant with an N of only 7.

The results of the present experiment again confirm previous findings that comprehension of time-compressed speech can be improved by simple practice routines to relatively high levels at speeds of about

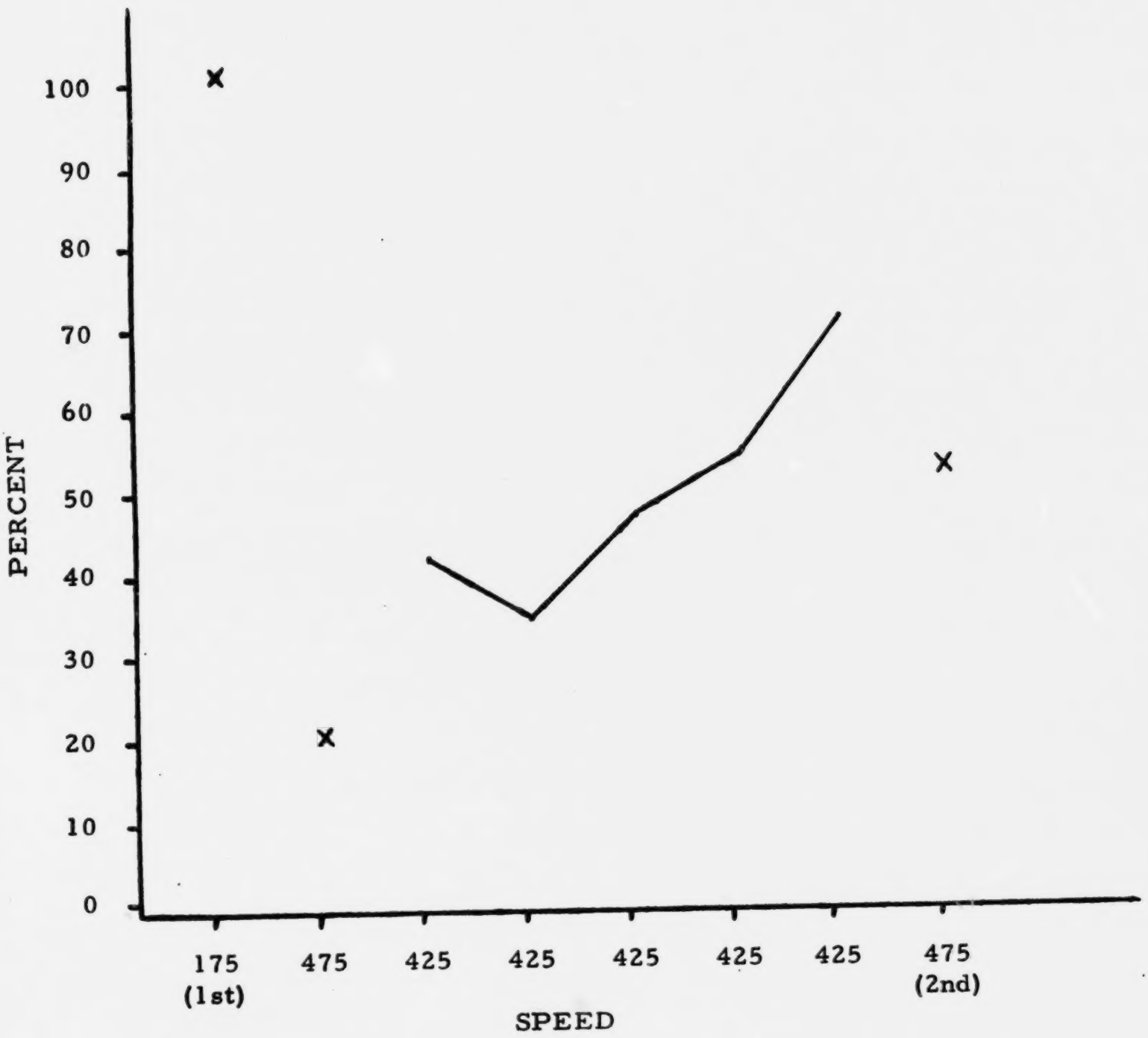

Fig. 1. Mean Percent of Normal Performance Over Five Days (N=7)

2-1/2 times normal. By the end of the week, all subjects had reached the 50 percent comprehension mark, although several started from as low as 5-10 percent on the first day. There is reason to believe that some further increases would have been obtained had the experiment been prolonged. The effects of the training on other variables such as reading test scores and standard listening test scores, while in the right direction, were not great, however.

Another question of interest is the effectiveness of the method here employed to achieve approximately 70 percent comprehension at 425 wpm. During their five days of intensive exposure, these subjects spent approximately 35 hours listening to compressed speech. How does this compare with previous findings? These results can be compared with those of the three previous groups of similar composition, all of which received about 12-14 hours of practice distributed at about 1-2 hours, 2-3 days per week, over about 4-5 weeks:

(1) Graduated practice from 325-475 wpm

(2) Graduated practice from 325-425 wpm (with periodic breaks)

(3) High speed practice (425 wpm only)

The mean result for group (1) above was 79 percent of normal at 425 wpm; for group (2) 80 percent at 425 wpm; and for group (3) 71 percent at 425 wpm. Thus, the investment of 12-14 hours of spaced practice produced results as good or better as the investment of almost three times as much practice in the present "immersion" study. A similar conclusion was reached after looking at the mean improvements from pre- to post-experimental scores on the repeated high speed (475 wpm) test passage.

With respect to the subjective comments gathered on the debriefing questionnaire, a few comments can be made. All subjects felt that practice had improved their ability to comprehend compressed speech and five of the seven felt that more practice would lead to further improvement. Attention wandering, particularly on less interesting parts of the practice material, was seen as one of the chief problems. However, most felt that their powers of concentration had been improved by the experiment. Finally, all subjects felt that their performances would be improved with the use of learning aids, such as outlines, key words, abstracts, simultaneous availability of the text, and selected repetition.

Summary and Implications:

The primary findings of this study were two-fold: (1) The findings of previous work were confirmed in that time-compressed speech is comprehensible, and the comprehension of time-compressed speech is trainable by means of simple practice; (2) While immersion in concentrated practice is effective in improving comprehension at high rates of speed, it is not an efficient method of practice as compared to less concentrated types of practice spread out over a longer period of time.

The findings of the present study tend to reinforce the conclusion that time-compressed speech offers substantial possibilities as an educational technique. Comparatively high levels of comprehension are possible after comparatively limited amounts of training at substantially increased rates of speed. Rather high levels of comprehension at 2-1/2 times normal speed can be obtained in a period as short as one working week by means of concentrated practice. Thus, the findings do confirm the feasibility of a concentrated training course in compressed speech as

a prelude to the regular school term, if the use of highly compressed speech should become a usual educational practice.

The Criterion Study

Problem:

The aim of this study was to determine the amount of practice listening necessary to reach the criterion of 90 percent of normal speed comprehension at the 375 wpm level. In previous experiments significant improvement in performance occured at 425 and 475 wpm, but the mean scores were well below 90 percent. It was the aim of this study to achieve 90 percent comprehension at a moderately high speed, and if successful go on to still higher speeds.

In addition, the method of measuring comprehension used to date has been rather cumbersome, requiring the use of entire passages and the construction of equivalent tests. Therefore, it was planned to examine an intelligibility measure (accurate reporting of the last word heard at certain intervals) as a possible correlate of comprehension.

Procedures:

The subjects used were ten male volunteers from the University of Maryland (nine sophomores and one freshman) between the ages of 18 and 22. None had previously participated in a compressed speech experiment. All had normal hearing as determined by a pure tone audiometric screening test; and all were native speakers of English with no marked regional accents. Subjects were paid $1.50 per hour plus carfare. In addition, six $10.00 bonuses were awarded during the course of the experiment on the basis of performance on the first administration of the listening tests.

The subjects were informed that throughout the experiment bonuses* would be paid for outstanding performance, and they must attend every session in order to receive payment for their participation. They were asked not to discuss the experiment with each other or outsiders. No feedback was given to the subjects regarding their scores.

The materials used were as follows:

a. Practice novels: Three novels previously recorded by the American Printing House for the Blind in their Talking Book series were selected and compressed to the required speeds:

(1) Cheaper by the Dozen. The first quarter at 325 and the remainder at 375 wpm.

(2) The Miracle New York Yankees at 375 wpm.

(3) Run Silent, Run Deep at 375 wpm.

Of the ones previously used at this speed, these had been the most popular.

b. Test materials:

(1) Quizzes on the information contained in the novels were used. They were comprised of multiple choice and essay questions, but were not standardized. They were written for a previous study and were used here to give the experimenters

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* These bonuses were awarded after performance on the first administration of the listening tests at 375 wpm. One bonus was awarded after each test. The award was announced at the immediately succeeding session. A bonus was given to the subject with the highest percent normal score on a given test, provided that his absolute score corrected for chance, was above the group mean. Subjects were not informed of the method of awarding bonuses, nor that the bonuses were given on the basis of the first administration only.

some idea of performance and to maintain subject motivation at a relatively high level.

The texts of the novels were used as follows: Each novel was marked at certain intervals at the ends of paragraphs. The tape was stopped at those intervals and the subjects were requested to write down the last word heard. They were asked to guess if uncertain. The ends of paragraphs were chosen to minimize disruption to the subjects and to maximize intelligibility scores since the high degree of contextual restraint could be expected to reduce the number of alternative responses from which the subjects might choose. The intervals were irregular to lessen the predictability of their occurence.

(2) Seven benchmark passages with five-option multiple choice tests were used. (These passages have been described in previous progress reports.) The passages were taken from a college level English history textbook called The English People on the Eve of Colonization, by Wallace Notestein. Twenty-five to thirty item multiple choice tests previously constructed and standardized on a similar population were employed as the chief measures of listening comprehension.

One passage ("C-1") was presented at normal recording speed (175 wpm), the remaining seven at 375 wpm.

Other materials consisted of pre-numbered pages on which the subjects were to record the "last-word heard" responses - there were always more numbers than responses called for to prevent subjects from knowing when that type of testing was completed. Alternate forms of the Nelson-Denny Reading test contain-

ing measures of reading rate, vocabulary, and comprehension, were used in a balanced way as pre- and post-experimental measures. The mechanical equipment was the same as that used in previous experiments. In addition a biographical questionnaire and a debriefing questionnaire calling for subjective reactions were used, respectively at the beginning and end of the experiment.

c. Test scoring: Most of the multiple choice tests contained 25 questions; two contained 30 questions. Scores on those two tests were pro-rated to give a proportional score for a 25 item test. All test scores were corrected for chance with the following formula $R - \frac{W}{n-1}$, where R equals the number of questions answered correctly; W, the number of questions answered incorrectly, and n equals the number of alternative answers for any given question.

Each subject's score on the first benchmark passage and test (given at 175 wpm) was taken as the baseline for his comprehension at normal speed. Each subject's subsequent scores were then expressed as a percentage of his score at 175 words per minute.

Scoring of last words: Words were scored correct or incorrect; hyphenated words were counted right if the last word was right. If the word had the wrong ending, it was counted wrong; if wrongly spelled, even homonyms, it was counted right.

Design:

Pre-experimental measures included the following: a biographical questionnaire, the administration of form A to one half the subjects (and

form B to the other half) of the Nelson-Denny Reading test; and a benchmark passage at 175 wpm. Following the initial session, experimental sessions lasted about three hours. Subjects never listened for more than one hour to any material without being given a ten minute break. All practice material (novels) was interrupted periodically for recording of "last words" and listening quizzes.

Five benchmark passages were presented at 375 wpm after 2, 7, 9.5, and 16 hours of listening practice. Following the administration of each passage and test 20-25 minutes of additional practice material was presented, after which the passage and test were administered a second time, with periodic interruptions during administration for measurement of "last word" intelligibility. (The exception was C-7 on the last day which was repeated without interpolated practice because of a shortage of time.) Finally, an additional passage and test were presented (but only once, with no interruptions) as the final performance measure. In addition the alternate form of the Nelson-Denny Reading test was administered; and subjects were required to fill out the debriefing questionnaire.

Results:

Table 2 shows the normal speed scores corrected for chance for each subject and the mean percents of these scores attained by the subjects on both first and second administrations separately. It also shows the highest percents of normal attained by each subject on the first administration and the number of practice hours at 375 wpm taken to reach that level.

Table 3 shows the mean percent normal comprehension over all subjects, by number of hours of practice for first and second admin-

TABLE 2

Highest Percent Normal Comprehension Attained By Subject and Number of Hours Practice to Achieve It (375 wpm)

Subject	Normal Speed (175 wpm) Score	Mean Percent Normal 1st Adm.	Mean Percent Normal 2nd Adm.	1st Adm. Highest Percent of Normal	Hours to Highest Percent
A	12.5	67.4	116.2	104.00**	16.0
B	17.5	46.7	73.0	85.71*	7.0
C	17.5	53.7	98.3	100.00	9.5
D	17.5	66.3	85.8	100.00	16.0
E	13.8	50.6	68.6	83.27*	2.0
F	13.8	58.8	121.9	90.91	16.0
G	17.5	73.1	102.5	95.71	16.0
H	13.8	77.7	112.9	116.36	7.0
I	16.2	61.8	106.4	73.85*	9.5
J	15.0	68.2	94.6	91.67	7.0
MEAN	15.5	62.4	98.0		10.6

* Below criterion

** This is the only subject who reached criterion on more than one occasion. His percent normal comprehension was 94.00, after 15 hours of practice.

TABLE 3

Mean Percent Normal Comprehension by Hours of Practice
Listening, First and Second Administrations, 375 wpm (N=10)

	Approximate Hours of Practice Novels and Passages						
	2	7	9.5	13	15	16	Mean
Mean %, 1st Adm.	58.8	77.2	58.3	48.7	54.5	77.2	62.4
s.d.	9.8	16.4	27.1	16.6	22.2	20.5	9.5
Mean %, 2nd Adm.	86.5	94.5	102.2	95.6	97.8*	--**	98.0
s.d.	24.4	27.0	25.8	32.0	18.4	--**	16.9

NOTE: The 2nd administrations came after about 20-25 minutes additional practice.

* No interpolated practice between 1st and 2nd administrations.

** C-8 was not re-administered because it was to be used again in a later stage of experimentation.

istrations of the test passages. Unlike previous experiments, there appeared to be no progressive improvement in these means with practice.

Table 4 shows the percent correct for last words on the test passages. Again no evidence of progression is apparent, although the generally high level of intelligibility is evident.

Although seven subjects attained criterion in this experiment, it is unlikely that these subjects attained a highly stable degree of comprehension of speeded discourse at 375 words per minute. Six subjects attained their highest comprehension within the first three sessions; however, these subjects did not maintain this level of comprehension. Even so, it was decided to carry out additional experimentation for two reasons. First, the last word scores did not appear to be a measure which might substitute for the multiple choice comprehension tests. Secondly, a comparison between mean scores on the last two first administrations of comprehension tests given on the final day (with no intervening practice) shows the mean score to be considerably higher on the second test (and all but one subject did better on the second test). Therefore, it was thought that practice consisting only of listening to materials similar to the test materials used and of test-taking on those materials, might produce higher comprehensions scores. That is, that the more similar practice materials were to the materials for which a subject was being trained, the better the performance might be on the latter.

Criterion Study, Part II

Six of the subjects who reached the criterion were asked to return for participation in a second criterion study in which the rate of speeded discourse was 425 words per minute. The subject who reached criterion

TABLE 4

Percent Last Words Correct

By Test and Subject

Subject	Passage and Test* C-3	C-4	C-5	C-6	C-7	MEAN
A	89	53	70	78	86	75.2
B	79	73	75	72	93	78.4
C	95	73	65	89	79	80.2
D	89	80	90	78	93	86.0
E	84	80	85	83	93	85.0
F	100	80	90	94	93	91.4
G	79	87	90	94	86	87.2
H	89	80	100	94	93	91.2
I	95	73	85	94	93	88.0
J	95	87	90	94	93	91.8
No. of trials (Base of %)	19	15	20	19	14	
Mean %	89.4	76.6	84.0	87.0	90.2	85.4

* In chronological order

after 9.5 hours of practice was not asked to return because his scores on the last three tests and his overall mean score were substantially below the group means. Another subject could not return, leaving five.

An artificially formed control group was formed from those subjects from prior experiments who had met the criterion at 375 wpm. Their scores on a standardized test at 425 wpm, after a given number of hours practice of novel listening, could be compared with the results of the present experiment in terms of scores on the same standardized test in order to discover if the method of training by similar materials and testing on those materials was superior to the method of training by listening to novels.

Procedures:

The experiment was conducted in four group* sessions, of three hours each, spread over eight days.

Materials: Ten practice passages and practice tests, taken from a variety of library and journalistic materials were used. One passage was taken from On the Eve of Colonization, the same book from which the passages in Experiment I came; this passage had been equated, and the test standardized with four standardized tests and passages used in Part I. Other materials used were the same as in Part I; however, the hearing test and Nelson-Denny Reading test were not given.

The experimental schedule was somewhat more involved than that for Part I, and is given below by days:

Day 1: Subjects' maximum oral reading rates were tested. Subjects listened to four short passages, of about 10 minutes duration each. After

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* One individual session was arranged because of scheduling difficulties.

each passage, the subjects were given multiple choice questions about the passage. Each passage and test were repeated twice in succession. During the repetition of each passage about 10 interruptions occurred, of about 5 seconds duration, each; and subjects were asked to record the last word they had heard before the interruption.

Day 2: Subjects listened to four short unstandardized passages; the method was the same as Day 1. Between the second and third passages, subjects listened to a continuation of Run Silent, Run Deep at 425 words per minute, for about 20 minutes. It was thought that maximum oral reading rate might be correlated with ability to comprehend rapid speech. Therefore the subjects were given a passage to read out loud. They were asked to read the passage as rapidly as possible. The time from beginning to end of the passage was taken for each subject.

Day 3: Subjects listened to two short passages, in the same manner as Days 1 and 2. They then listened to the test passage for this experiment, taking a standardized multiple choice test. The passage was repeated with interruptions for recording of the last word heard. The test was repeated. After all testing for the day had been completed, subjects listened to the final portions of Run Silent, Run Deep, at 425 words per minute.

Day 4: A passage was repeated for the third time, reading questions first. A second passage was repeated for the second time. Subjects were asked to make any comments they wanted to, in writing.

Results and Discussion:

Table 5 shows the results of the criterion study, Part II. It is evident that the subjects did slightly less well on the average than they did in Part I, for both first and second administrations of the practice

TABLE 5

Percent of Normal Speed Comprehension Scores by Subject and Amount of Practice at 425 wpm, Criterion Study, Part II

Subject****	*Mean, 1st Adm. 9 Practice Pass.	*Mean, 2nd Adm. 9 Practice Pass.	**Test Pass. C-2	Test Pass. C-2 (repeat)	***Test Pass. C-8
D	50.8	77.3	29.8	90.5	107.1
	(66.3)	(85.8)	(100.0)		
F	54.0	105.0	77.2	153.0	94.6
	(58.8)	(121.9)	(90.9)		
G	70.1	104.9	59.5	125.0	85.7
	(73.1)	(102.5)	(95.7)		
H	78.4	110.8	65.2	115.1	125.4
	(77.7)	(112.9)	(90.9)		
J	62.2	99.7	73.6	127.8	125.0
	(68.2)	(94.6)	(45.0)		
MEAN	63.1	99.5	61.1	122.3	107.6
	(68.8)	(103.5)	(84.5)		
Average Cumulative Average amount of practice (hrs), Part II	.97	1.1	2.2	2.3	3.0

* Criterion Study, Part I mean scores (375 wpm) are given in ( ) for comparison.

** For comparison the last test passage score in Part I (375 wpm) is given in ( ).

*** This passage was a repeat of the last passage given in Part I at 375 wpm.

**** Refers to Part I Identification Code.

passages. Of course the Part II scores represent tests at 425 wpm, while the Part I scores were taken at 375 wpm. Thus the additional practice was not sufficient to offset the increase in rate.

The comparatively large difference between mean percent of normal for a new test passage in Part II as compared to the last test passage in Part I for these subjects suggests more than simply a loss attributable to the increase in speed. Possibly there was a diminution in motivation during the Part II experimentation, which should have been getting somewhat boring to these subjects by this time.

The efficacy of repetition continued to be clearly evident, as it was in Part I.

When the performance of the Part II group is compared to the ad hoc group of subjects from previous experimental groups who had reached 90 percent at 375 wpm at some time, we find that the Part II group mean on a new passage at 425 wpm was 61. 1 percent versus 82. 8 percent for the comparison group. This difference cannot be attributed to differences in amount of practice as the Part II group had a slightly greater number of total hours of practice. This finding is certainly not stable because of its ad hoc nature, but does not provide any support for the hypothesis that practice on materials similar to the test materials was superior to practice on the novels.

A number of rank order correlations were done to tentatively examine the relationships in the data. Few consistent relationships were observed. For the Part I group, a correlation of . 50 was obtained between mean last words on the first administration of practice passages and comprehension score on the first administration of a new test passage. Although this is a relatively stable estimate, when the last words score was correlated

with comprehension score on the same passage, the correlations ranged from . 72 to -. 51 over five passages. It can only be concluded that the last words score is no substitute for comprehension scores. Part II results bore out this conclusion.

One interesting result of the last words data however was the finding that some subjects did comparatively well on the listening comprehension score for a test passage, but relatively poorly on last words. This indicates that comprehension is not unduly dependent upon the intelligibility of specific words.

One further correlation was computed for the Part II subjects, reading rate (aloud) with comprehension score on a new passage toward the end of the experiment. A rank order correlation of . 70 was obtained which is also probably not a highly stable result.

The comparatively disappointing results of the Criterion study may be due to one or more of several factors. First the interruptions associated with determining last words may have been disruptive. Secondly, the repetition of material may have proved boring to the subjects. Third, it was subsequently discovered that the subjects had set up a "bonus pool" amongst themselves to distribute the bonuses. This raises some questions as to the legitimacy of the results. In any case however, the Criterion study must be taken as tentative and on the order of a pilot study. It did serve the useful function of permitting the try out of a number of new techniques and procedures.

Summary:

1. Seven of ten subjects reached 90 percent of normal speed score at least once on a listening test presented at 375 wpm after up to 16 hours of listening practice at 375 wpm. Subjects could not be con-

sidered to have reached the criterion consistently, however as little evidence of progressive improvement with practice was found.

2. There was no clear correlation between the intelligibility measure and comprehension scores, correlations vascillating from positive to negative.

3. The second presentation of a passage almost always resulted in a much higher score. This effect cannot be attributed simply to repeated questions.

4. Subjects generally did not achieve criterion at 425 wpm within the limits of the 3 or so hours of additional practice material employed.

5. There was no evidence to suggest that practice on materials similar to test passages was superior to practice on novels.

6. A hint of relationship between oral reading rate and listening comprehension at 425 wpm was found.

The Retention Studies

Introduction:

In addition to the questions of how well it can be understood, and to what degree it is trainable, a major question in using compressed speech as an educational technique is to what extent the skill of listening to compressed speech is retained, and to what extent material learned via compressed speech presentation is retained. The three experiments described below provide some information regarding these questions.

Retention Study No. I

In November of 1964 eleven of the original (Spring, 1964) sixteen experimentals, and thirteen of the original sixteen control subjects (from the graduated practice experiments) returned for a single session. (For original data see Progress report June 1964.) The purpose of the session was to measure both degree of retention of content of material heard at a variety of high speeds the previous spring; and to measure the degree to which the skill of comprehending high speed speech was retained.

For the measurement of content retention the tests which had originally been administered after presentation of passages C1 - C5 at speeds ranging from 175 to 475 wpm, were readministered without any passage presentation. For the measurement of skill retention a new equivalent passage and test were presented at 425 wpm.

A comparison of experimental and control mean scores over the five tests (C1 - C5) which were administered without presentation of the passages, showed no difference between the groups. The respective mean scores of the experimentals and controls were 6.9 and 8.0 over all passages and were not significantly different. Since the original presentation of the passages occurred under varying conditions of speed and amounts of practice, the percentage of loss cannot be adequately determined. However, the lack of difference at this point suggests that experimentals retained their content as well as controls did.

Performance on the new passage (C-6) was compared with performance on a similar passage (drawn from the same book by the same author) which was presented at the same speed (425 wpm) at the end of training in the spring session. Mean performance for those experimental

subjects able to return declined from 11.7 in the spring to 9.1 in the autumn (based on 25-item tests, and corrected for chance). Control subjects showed a decline from 8.5 in the spring to 7.5 in the autumn. While the decline for both groups was statistically significant at the five percent level (one-tailed), these losses of 22 percent and 12 percent respectively are not statistically different and may be considered quite modest over an interval of about 4 months.

Although the experimentals still performed better (9.1 vs. 7.5), they were no longer statistically different from the controls. Even so, it should be noted that there was some indication that the control group was a superior listening group to begin with. (The respective original scores at normal speed for experimental and control groups were: 16.0 and 17.6; at 475 wpm they were 4.2 and 6.5.) There was therefore, a tentative suggestion that even six months after training some training effects may have remained with the experimental subjects.

An examination of correlation between initial (prior to any training) performance at normal speed with current 425 wpm performance showed about the same correlation for experimentals (.56) as for controls (.39). As the former is significant, while the latter is not, some effect of the practice on the interaction with normal listening is indicated. A comparison of correlations between performance at high speed (425 wpm) immediately after training (spring) and current 425 wpm performance showed a striking difference between experimentals and controls (.73 vs. .17). This significant difference further suggests some residual effect of the practice listening received by the experimentals.

Retention Study No. II

During the Spring of 1965, it became necessary to standardize some additional benchmark tests and passages. Therefore a group of college freshmen and sophomores comparable to those students used as subjects was assembled and given the new passages and tests along with several old ones. One month later they were re-assembled and the tests repeated without the passages.

Procedures:

Passages C-3, C-6, C-7, and C-8 were administered in that order at 175 wpm, each followed by its test. Finally Passage C-2 was administered at 425 wpm. Students were urged to do their best, were paid $7.00 and a $15.00 bonus for the best overall score was offered.

One month later the group was re-assembled and the tests for C-3, C-6, C-7, C-8 and C-2 were re-administered without exposure to the passages. Following these a new passage and test was administered at 425 wpm and another new passage and test was administered at 325 wpm. Again the students were paid for their time and a bonus was awarded.

Results:

The results are summarized in Table 6. It may be seen that on the average about 60 percent of the content of the four passages presented at 175 wpm was retained over the period of one month. This finding compares favorably with the retentions of similar materials which have been read.

The loss in retention of 90 percent between first and second administrations of C-2 is certainly not discouraging evidence of retention of

TABLE 6

Mean Scores, Corrected for Chance and Prorated to a Base of 25 Items for Retention Study No. II (N=35)

Passage & Speed	1st Session Mean	2nd Session Mean	Percent Loss
C-3 (175)	13.9	9.2*	34
C-6 (175)	16.3	9.7*	40
C-7 (175)	9.5	4.7*	51
C-8 (175)	12.6	7.9*	37
C-2 (425)	5.7	5.2*	9
C-4 (425)		2.4	
C-5 (325)		3.0	

* Retests

high speed presentations. The level of initial performance at this speed (remembering that these students had had no prior exposure to speeded material) was about 43 percent of normal speed comprehension, which is just about typical for naive subjects at 425 wpm. This percentage jumped to 66 percent on the re-test however, since comparatively greater loss occurred for the normal speed than for the speeded material. Although the scores were corrected for chance, it is likely that some of this stability at high speed was a function of prior knowledge and chance. In any case, however, the retention of content certainly appears to be no worse for speeded material than for normal speed material.

The new passage (C-4) administered at the second session was intended to provide a comparison between the scores for the group on their first exposure to a speeded passage (C-2, first session) and their scores on a comparable new passage one month later. Thus, if they had acquired any skill in the first exposure, the second would measure the retention of that skill.

It was recognized that this test was not a strong one since the amount of skill which could be expected to result from a single exposure would necessarily be small. However, the comparison was made. Table 6 shows that the group score was significantly lower at the time of second testing at speed 425. This lower score can also be attributed to the fact that while the experiment was in progress, frequent interruptions occurred due to factors beyond the control of the experimenter. Similarly the group mean score for skill at listening to 325 wpm without prior experience with this particular speed was extremely low. In fact, the mean score at 325 wpm was lower than the mean score the group obtained upon first listening to 425 wpm. It therefore seems likely that the tests measuring this

group's retention of skill in listening to speeded speech cannot be said to allow us to interpret in any meaningful way the retention of this skill.

In summary, then, this experiment provided tentative evidence that listening retention over a month compares favorably with reading retention; and that retention of speeded presentations appears to be at least as good as for non-speeded presentations.

Retention Study No. III

A further examination of the question of retention was obtained by recalling the Spring 1965 experimental group which had practiced comprehension of speeded speech on the order of 12 hours, all at one high speed (425 wpm). This group had performed in a manner comparable to previous experimental groups (See Progress Report No. 1, July 1965), and had displayed a significant improvement in comprehension as a function of practice. It thus could be called a group of practiced listeners.

Procedures:

The group was recalled one month after the conclusion of their experimentation and the procedure of Retention Study II repeated. Tests on passages C-1, C-4, and C-5 which had been originally heard at some combination of 175, 325 and 375 wpm were re-administered without the passages. The same was done for tests on passages C-2, C-3 and C-6 which were originally heard at 425, 475, and 175 wpm, respectively. Finally, new passages and tests C-7 and C-8 were administered at 425 and 325 wpm, respectively.

Results:

Table 7 shows the results of this testing. Again, content retention

TABLE 7

Mean Scores, Corrected for Chance and Prorated to a Base of 25 Items for Retention Study No. III (N=16)

Passage & Speed	Experimental Sessions Means	Recall Session Means	Percent Loss
C-1 (175)*	9.8	8.3	15
C-4 (175)*	11.2	7.5	33
C-5 (175)*	9.1	5.9	35
C-2 (425)	7.0	8.1	-16 (gain)
C-3 (475)	5.6	5.5	2
C-6 (175)	12.9	8.2	36
C-7 (425)		6.0	
C-8 (325)		11.8	

* A mixture of speeds (175, 325, and 375 wpm) occurred on the 1st administration.

of both normal, and particularly speeded passages was high over this one month period. For highly speeded passages (425, 475 wpm) retention was 116 percent and 98 percent respectively of first session scores. For passages presented at normal or for some mixture of normal and speeds up to 375 wpm retention averaged about 70 percent of first session scores.

A comparison of the mean score on the new passage at 425 wpm at the second session with the mean score on a different 425 wpm passage at the end of the experimental sessions one month earlier shows a loss of only 14 percent. However, the obtained mean score on this skill retention test (6. 0) was not significantly different from that obtained by the Retention Study No. II group on its first exposure to compressed speech at 425 wpm (5. 7). This latter score was 43 percent of normal speed scores for the Retention Study No. II group, while a comparison of the present retention groups mean score at the recall session to their original normal speed scores of the previous month (i. e., to a normal speed naive base) also showed 43 percent. Thus, there is little evidence available in this study for retention of acquired skill in listening to compressed speech.

Further, comparison of the recall session mean score at 325 wpm (11. 8) with the mean score of a composite of several passages at 325 wpm (13. 2) on the experimental sessions a month earlier showed a loss of about 11 percent over the period of the month. This comparison shows only a slightly better score one month after the experiment than would be expected from a naive group at this speed. Again, little evidence of skill retention is apparent.

Overall Summary

The experiments described in this Progress Report are of three types: The Immersion Study consisting of intensive practice over a short period of time; the Criterion Study in which it was attempted to bring subjects to a criterion of 90 percent of normal speed comprehension scores at 375 and 425 wpm; and the Retention Studies which sought to measure the degree to which subjects retain both the skill and content of speeded speech listening.

The Immersion Study confirmed previous research in that practice in listening to compressed speech improves performance at 425 wpm. The intensive nature of the exposure achieved results comparable in level to those of previous experiments, at the cost of more than doubling the total amount of listening practice required although this was accomplished in one week instead of four.

The Criterion Study was somewhat disappointing in spite of the fact that seven of the ten subjects achieved the criterion level (90 percent of their own normal performance) at 375 wpm. The results however were rather inconsistent and it is questionable that any subject would score consistently at or above criterion. This was the only experiment to date in which the group did not show a significant upward trend, and it is felt that the introduction of frequent pauses to measure intelligibility may have created too much distraction for effective practice listening. The intelligibility measure suggested that the material used was highly intelligibile, however contrary to predictions, it did not correlate significantly with comprehension scores.

The second part of the Criterion Study at 425 wpm was similarly unrewarding, although it was again demonstrated that repeating a passage

produced great improvement over the first exposure. These repetitions may also have contributed to lack of overall improvement, however, by introducing monotony. Further there was no evidence that practicing on test-like material was more effective than practicing on novels.

The three Retention studies suggested that the content of that which is learned by listening to compressed speech is as well retained as that learned by listening to normal speed tapes. However, the results obtained in testing the retention of the skill in listening to high speed speech were somewhat inconclusive. Study No. I provided some positive evidence of retention of skill, but study no. III failed to bear this out (Study No. II was essentially irrelevant on this point.) Of course, measurement of retention using the "savings" method, measuring the amount of time to re-train, might provide more positive results. It should be borne in mind that if speeded speech were to be used in the educational setting it would not be presented only at isolated times separated by long intervals. It is felt that if consistent use is made of compressed speech, the skill would not be lost.

Further Research

Additional work remains to be done. Under the present grant it will include the following categories of experimentation:

1. An examination of a variety of listening aids including summaries of listening material, key word lists, greater isolation of subjects, etc. as a better means of training comprehension of speeded speech.

2. An examination of the use of compressed speech with different types of material than those used to date. It is planned to use psycho-

logical and physical science material as opposed to the literary-historical material currently being used.

3. An examination of the usefulness of speeded speech as a review technique. Students who are familiar with specific material will be able to review this material by listening to compressed tapes of it as compared with a control group reviewing in the conventional manner.

4. An examination of the variables involved in the simultaneous presentation of visual and auditory material, compressed in time.

5. An exploration of self-pacing techniques (i. e., the adjustment by the listener of the rate of presentation of material to which he is listening) as a means of learning more about comprehension and training of compressed speech.

6. Additional retention studies employing the "savings" method to bring subjects back up to a criterion level of performance.

7. An additional examination of the impact of training on normal speed performance.

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APPENDIX A

Immersion Study

Practice Materials and Schedule of Presentation (all at 425 wpm)

	Material	Elapsed Time
(Day 1)	Cheaper by the Dozen	45
	Quiz	10
	Break	5
	Cheaper by the Dozen	40
	Quiz	10
	Cheaper by the Dozen	65
	Quiz	10
	Quiz	10
	Break (lunch)	60
	Diary of a Young Girl	67
	Quiz	5
	Break	10
	Diary of a Young Girl	59
	Quiz	10
	Break	15
	Diary of a Young Girl	43
	Quiz	5
	Break (dinner)	60
	Benchmark Passage C-4	12
	Test C-4	13
	Diary of a Young Girl	48
	Quiz	5
	Break	10
	I Owe Russia $1200	79
	Quiz	8
(Day 2)	I Owe Russia $1200	60
	Break	10
	I Owe Russia $1200	25
	Quiz	5
	Quiz	5
	The "Miracle" New York Yankees	49
	Quiz	5
	The "Miracle" New York Yankees	15
	Break (lunch)	65
	The "Miracle" New York Yankees	32
	Quiz	5
	The "Miracle" New York Yankees	32
	Quiz	4
	Break	20

APPENDIX A

	Material -	Elapsed Time
	To Kill a Mockingbird	57
	Quiz	5
	Break	15
	To Kill a Mockingbird	54
	Quiz	6
	Break	10
	To Kill a Mockingbird	54
	Quiz	3
	Break (dinner)	60
	Benchmark Passage C-5	10
	Test C-5	10
	To Kill a Mockingbird	44
	Quiz	3
	Break	2
	To Kill a Mockingbird	45
	Quiz	5
(Day 3)	The Excitement of Science	53
	Break	14
	The Excitement of Science	9
	Quiz	7
	The Excitement of Science	30
	Break	13
	The Excitement of Science	31
	Quiz	5
	Break (lunch)	65
	The Forgotten Pioneer	65
	Quiz	5
	Break	15
	Man Eaters of Kumaon	47
	Quiz	7
	Break	18
	Man Eaters of Kumaon	52
	Quiz	7
	Break	5
	Man Eaters of Kumaon	19
	Break (dinner)	60
	Benchmark Passage C-6	8
	Test C-6	10
	Man Eaters of Kumaon	35
	Quiz	5
	Break	10
	Man Eaters of Kumaon	48
	Quiz	5
	Questionnaire	15

APPENDIX A

	Material	Elapsed Time
(Day 4)	How to Win Friends and Influence People	50
	Quiz	5
	Break	14
	How to Win Friends and Influence People	47
	Quiz	6
	Break	13
	How to Win Friends and Influence People	33
	Break (lunch)	64
	How to Win Friends and Influence People	16
	Quiz	3
	How to Win Friends and Influence People	31
	Break	15
	How to Win Friends and Influence People	16
	Quiz	4
	Run Silent, Run Deep	24
	Break	11
	Run Silent, Run Deep	54
	Break	10
	Run Silent, Run Deep	39
	Quiz	6
	Break (dinner)	70
	Benchmark Passage C-7	8
	Test C-7	10
	Run Silent, Run Deep	30
	Break	15
	Run Silent, Run Deep	50
	Break	5
	Run Silent, Run Deep	17
	Quiz	15
(Day 5)	Run Silent, Run Deep	45
	Break	10
	Run Silent, Run Deep	60
	Quiz	10
	Break	18
	America's Race for the Moon	31
	Break (lunch)	65
	America's Race for the Moon	18
	Quiz	6
	America's Race for the Moon	31
	Break	12
	America's Race for the Moon	8
	Quiz	5

APPENDIX A

Material	Elapsed Time
Riders of the Purple Sage	29
Break	15
Riders of the Purple Sage	27
Quiz	4
Riders of the Purple Sage	18
Break	9
Riders of the Purple Sage	38
Quiz	6
Break (dinner)	70
Benchmark Passage C-2	8
Test C-2	10
* Benchmark Passage C-3	8
* Test C-3	11
Riders of the Purple Sage	20
Break	10
Riders of the Purple Sage	61
Quiz	5

* repeat of pre-experiment measure.